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CONCERNING A FILING UNDER 35 U.S.C. 371

RBL0079

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

09/869614

INTERNATIONAL APPLICATION NO.
PCT/EP99/09728 ✓INTERNATIONAL FILING DATE
10 December 1999 (10/12/99)PRIORITY DATE CLAIMED
08 January 1999 (08/01/99)

TITLE OF INVENTION

MEASURING SYSTEM FOR THE CONTROL OF RESIDUAL DUST IN SAFETY VACUUM CLEANERS ✓

APPLICANT(S) FOR DO/EO/US

NIEUWKAMP, Wolfgang ✓

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Check No. 052924

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.492(a)(1)-(5)) 09/869614		INTERNATIONAL APPLICATION NO. PCT/EP99/09728		ATTORNEY'S DOCKET NUMBER RBL0079	
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21. The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1,000.00					
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00					
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$860.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	18 - 20 =	0	x \$18.00	\$0.00	
Independent claims	- 3 =	0	x \$80.00	\$0.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$860.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>				\$0.00	
SUBTOTAL =				\$860.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$860.00	
				Amount to be:	\$
				refunded	\$
				charged	\$

☒ A check in the amount of **\$860.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
 A duplicate copy of this sheet is enclosed.

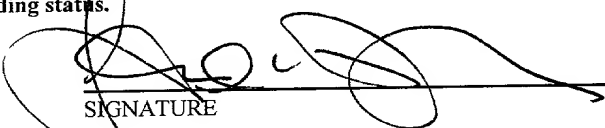
☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-0385** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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John F. Hoffman
 NAME

26,280
 REGISTRATION NUMBER

June 29, 2001
 DATE

TRANSLATION

WO 00/40136
PCT/EP99/09728

MEASURING SYSTEM FOR THE CONTROL OF RESIDUAL
DUST IN SAFETY VACUUM CLEANERS

(0001) The invention relates to a measuring system in the monitoring of residual dust for safety vacuum cleaners according to the generic term of the independent patent claim 1.

(0002) Similar measuring arrangements for the monitoring of the dust concentration in the exhaust air in vacuum cleaners are already known and these employ physical measuring principles such as, for example, the measurement of the differential pressure or of the radiation reflection.

(0003) In differential pressure measurement the prevailing pressure before the filter unit is compared with the prevailing pressure after the filter unit or after the motor, the differential pressure not being allowed to pass below a threshold value. With a non-defective and unfouled filter the admissible differential pressure is least, the differential pressure increases with increasing blockage of the filter. If the filter cracks, then an inadmissible pressure balance between the chambers before and after the filter arises and the differential pressure falls below the admissible threshold value in the direction of zero differential pressure. The undershooting of the differential pressure with a cracked filter, but also the exceeding of the

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differential pressure with a blocked filter, can be used as alarm means for purposes of the motor control.

(0004) A disadvantage in the measuring principle with the differential pressure method is that the pressure fluctuations, caused by running fluctuations of the motor because of changing volumes and speeds of the suction medium and by differing blocking and quality of the filter, are nevertheless so high that an exact registration of the undershooting or exceeding of the threshold value can be achieved only inadequately especially in the case of low differential pressures.

(0005) With DE-GM 92 09 407.4 there has become known a detection device of filter breakage in vacuum cleaner arrangements, which device uses the principle of infrared radiation reflection for the particle measurement in the exhaust air. In the exhaust air channel of a vacuum cleaner arrangement there are arranged an infrared sender and an appertaining infrared receiver angularly offset to one another on the circumference of the exhaust air channel, long-wave energy being radiated into the exhaust air channel by the infrared sender. This infrared radiation is then partly reflected on the dirt particles flowing through in such manner that the reflection radiation is registered over the infrared receiver offset, for example, by 90° to the infrared sender.

(0006) The energy supplying and the measuring signal preparation occurs (sic) in an evaluating electronic system connected with the sender and receiver. The measuring field is defined by the overlapping of the respective input and output jet cone.

(0007) On concentration rise of the dust particles in the exhaust air channel the IR energy irradiated by the sender is reflected (amplified) on the particles and measured in the receiver and in this manner a threshold value preset in the evaluating electronic system can be overstepped, which threshold value triggers an alarm and/or brings the motor to a standstill. Hereby a filter breakage is to be measured and displayed, in order to avoid health-threatening particle emissions into the environmental air, by manual or automatic switching off of the suction motor, and to make possible a filter change in proper time.

(0008) A disadvantage in the measuring principle with infrared radiation reflection for the residual dust particle measurement is that the optical system can be very easily soiled, both that of the IR sender and also that of the IR receiver, whereby the measurement signal is falsified, since the dust particles on sender and receiver likewise absorb and reflect IR energy; these dirt particles, however, are not to be measured, since, after all, they do not reflect the actual flow state in the exhaust air channel. This falsification of the measurement signal by fouling can be poorly compensated,

since the degree of fouling is constant neither in time nor locally, and therewith cannot be exactly defined. Thereby for an effective measurement, whether technical and/or computational, compensation is possible only very defectively.

(0009) A further disadvantage of the measuring principle with infrared radiation reflection for the residual dust particle measurement is that the measurement is restricted to the focusing range of sender/receiver. I.e, the measurement field defined by the overlapping of the radiation cones of sender and receiver does not cover the entire cross-section of the outlet tube (Auslassrohres), whereby outside of the measuring field no particle measurement takes place, which likewise leads to an undefined, poorly compensatable falsification of the measurement signal.

(0010) The problem of the invention, therefore, is to further develop a measuring system for the residual dust monitoring in safety vacuum cleaners in such manner that the above-mentioned disadvantages of the state of the art are reduced or even eliminated, namely that the measuring system is more sturdily constructed and makes possible a more dependable and more accurate measurement also in the case of low particle concentration in the exhaust air.

(0011) Here the measuring system, on the one hand, is to be less subject to fouling and therewith to make possible

longer maintenance intervals; on the other hand, it is also meant to make possible a more accurate measurement of the particle concentration in the exhaust air, in order to give more exact information about the state of the filter, as to whether a defect is present or not. It is also to make it possible to determine low dust concentrations in the exhaust air.

(0012) For the solution of the problem posed there serves the technical teaching of the independent patent claim 1.

(0013) An essential feature there is that, according to the invention, the measuring system of the residual dust monitoring in safety vacuum cleaners provides that at least one measuring electrode is mounted upstream behind the filter unit, which measuring element transmits a current produced by contact tension between measuring electrode and particles in dependence on the particle concentration to a measurement value processing unit. (Aufbereitung).

(0014) There arises here a contact voltage through intensive contact of the dust particles carried along in the carrier medium (air) with the material of the measuring electrode. If the dust particles consist of a material which is materially different from the material of the measuring electrode, then there occurs a passing-over of electrons which flow off to the lower potential as a function of the contacting particles and therewith of the particle

concentration in the exhaust air. This holds for electrically conducting particles as well as also for the electrically insulating particles. With electrically conducting particles the cause of the charge separation lies in the differing emergence work in comparison to the measuring electrode, and with electrically insulating particles in lies in the different electron affinity in comparison to the measuring electrodes.

(0015) In a preferred form of execution of the measuring system of residual dust monitoring for safety vacuum cleaners according to the invention, it is provided that at least one measuring electrode is arranged downstream within the outlet tube behind the filter and behind the turbine, preferably in the end zone o f the outlet tube. Also, it must be possible to arrange the measuring electrode in the vicinity of the turbine in the outlet tube or in the motor block of the turbine itself.

(0016) In a further form of execution of the inventive measuring system of the residual dust monitoring in safety vacuum cleaners it is provided that at least one measuring electrode is mounted downstream behind the filter or in front of the turbine, preferably directly on or in the near zone of the filter outlet surface. The measuring electrode can, however, also be arranged in an intermediate tube or an intermediate chamber between filter and turbine or else in the vicinity of the turbine in the motor block.

(0017) It is preferred that the measuring electrode cover the entire flow cross-section, but in such manner that the flow resistance in the safety vacuum cleaner is only inappreciably increased and thus the efficiency of the vacuum cleaner is not impaired by the measuring arrangement.

(0018) Preferably, therefore, at least one measuring electrode covers the entire filter output surface, the cross-section of the intermediate tube, or the intermediate chamber between filter and turbine, or the entire cross-section of the outlet tube.

(0019) In a preferred form of execution the measuring electrode is constructed in grid form, similar to a mesh wire or perforated plate, and it lies with its mantle surface firmly on the inner circumference of the tube or of the chamber.

(0020) The grid-form measuring electrode can be bounded by an annular element around the mantle surface, in which case preferably the annular element consists of the same material as the measuring electrode, but it can, however, also consist, for example, of flexible plastic, into which the measuring electrode is cast and is thrust with clamping effect into the outlet tube. The fixing into position (Festlegung) of the measuring electrode can occur over a releasable or unreleasable connection, preferably, however, over a releasable screw, rest or clamping connection, or a welding connection.

(0022) If the measuring electrode lies directly on the filter outlet surface or in its vicinity, then it has about the same form as the filter, therefore, for example, likewise a cylindrical/tubular form or disk form can be joined with the filter on its face side and/or mantle surface.

(0023) It is also to be provided that several grid-type measuring electrodes be provided, which again transmit their measuring signal to a measuring value processing. Here there can additionally also be measured for information about the level of the particle concentration, the distribution of the particle concentration over the cross-section of the outlet tube, and therewith the position of the filter defect can be determined. This holds, of course, only for a measuring electrode that is located between filter and turbine, since the particles in the turbine substantially change their flow path, so that a correlation between measuring point and particle concentration behind the turbine or also in the vicinity in front of it is no longer possible.

(0024) Through the fact that the dust particles can be charged in a certain manner before their contact with the measuring electrode already in the inlet channel, in the dust chamber (housing), in their passage through the filter and the turbine and in the outlet channel, the dusts particles are preferably discharged before contact with the measuring electrode, in order to keep measurement value falsifications slight.

(0025) This takes place by grounding of the parts of the safety vacuum cleaner which first come in contact with the particles before the latter encounter the measuring electrode.

(0026) As a rule a grounding of the turbine housing suffices which with low protection demands is directly grounded, and in the case of high protective requirements is laid on artificial ground, therefore over protective impedances with one of the phases, or is electrically conductively connected with one of the phases or with the zero conductor of the turbine motor.

(0027) It is also possible, instead of this or additionally, to ground the housing of the safety vacuum cleaner, which is mostly standardly provided also for operator safety reasons when the housing is not insulatingly constructed.

(0028) Under the above-mentioned protection requirements there are to be understood contact and foreign-body protection, water protection and explosion protection, in which context there fall under Ex protection both the use of the apparatus in a danger zone (for example tank location zone), and also the use of the apparatus with hazardous substances (for example drawing-off of explosive gases and fluids).

(0029) Since the electrical currents to be measured in the measuring electrode, by reason of the contact voltage through intensive contact of the dust particles carried along in the

carrier medium (air) with the material of the measuring electrode, amount merely to a few nano-amperes (nA, 10^{-9}), for the further processing of the measuring signal, this signal must first be amplified.

(0030) Here a differential amplification offers itself, for example over a linear, inverting, differentiating operation amplifier, which inverts the measuring signal and amplifies it in respect to potential ground or artificial ground, correspondingly into the milli-ampere range (mA, 10^{-3}).

(0031) Of course all possible constructions of an operation amplifier can be provided, such as adders, subtractors, integrators, differentiators and all combinations of these, depending on what is to be measured and how the reckoning is to be performed.

(0032) It is obvious that this operation amplifier is preferably accommodated in a microchip and/or on a microprocessor which, for example, also fulfills still other assignments, such as, for example the turbine regulation or other measuring, controlling and regulating assignments. It is possible, for example, for corresponding measurement values or indications to be issued on displays on the apparatus or only in case of disturbance.

(0033) This operation amplifier, microchip or microprocessor can then be connected over a usual interface with a personal computer or another data processing apparatus in order from there to coordinate measuring, control and

regulating problems or in order to read out from the storage unit of the microchip or of the microprocessor, for example for statistical purposes. There can also occur a calibration over the PC, in which the threshold values for the further processing of the measurement signal are input, such as for example triggering of the alarm or switching on and off of the turbine.

(0034) If the filter unit is defective (for example burst or torn), then the particle concentration in the exhaust air stream rises rapidly and many more particles contact the measuring electrode and therewith the current flow rises away from the measuring electrode, and therewith the evaluating unit engaged on outlet side in the amplifier stage. Here then the measured value (actual value) is compared with the threshold value (desired value) and then an optical and/or acoustic alarm signal is given. In addition to this or as a replacement for this the turbine motor can be switched off automatically, which must be accomplished manually in the case of the exclusive optical and/or acoustic alarm signal.

(0035) The present invention is conceived, to be sure, preferably to detect an ever so slight filter leakage, but this measuring arrangement can also be used to detect, to display the blocking of the filter, to trigger optical or acoustic alarm, to turn off turbines automatically or by hand, or to modify the action of the suction stream on them, or to change filters automatically or by hand. If, therefore, the filter is blocked, then a predetermined threshold value of the

measuring signal is undershot and again and optical and/or acoustic alarm signal can be given or the turbine motor can be shut off. In distinction to the turbine standstill, in which no measurement signal is registered, with blocked filter and switched-on turbine a slight particle concentration is still measurable.

(0036) In forms of execution of the safety vacuum cleaner with several independent filter units, by the exceeding of the preset threshold value internally and automatically, the suction medium can be led to another turbine with unused/nondefective filter unit and it is not until the last unused/nondefective filter is likewise used-up that an alarm is given.

(0037) In the forms of execution of the safety vacuum cleaner with several independent turbines, by the exceeding of the preset threshold value internally and automatically the suction medium can be led to another turbine with unused/nondefective filter unit and it is not until the last unused/nondefective filter is likewise used-up that an alarm is given.

(0038) For the reduction of disagreeable or health-harmful noises through the grid-form measuring electrode in the flow channel, it can be provided that in the region of the outlet channel a sound damper is provided, which influences the sound vibrations in such manner that the noise level is lowered below an admissible degree. Preferably the

arrangement of the sound damper is made downstream at the free end of the outlet channel.

(0039) The inventive object of the present invention is yielded not only for the object of the individual patent claims, but also from the combination of the individual patent claims among one another.

(0040) All the indications and features disclosed in the documents, inclusive of the abstract, in particular the spatial formation represented in the drawings, are claimed as essential to the invention insofar as they are novel individually or in combination with respect to the state of the art.

(0041) In the following the invention is explained in detail with the aid of drawings representing only one course of execution. Here there proceed from the drawings and their description further inventively essential features and advantages of the invention.

(0042) Fig. 1 shows the measuring system according to the invention for the residual dust monitoring for safety vacuum cleaners with schematic electrical wiring. Here the upper part of the safety vacuum cleaner is represented in section and the grid-form measuring electrode is mounted in the free end of the outlet channel.

(0043) Fig. 2 shows a first switching principle of the grounding of the turbine for low protection requirements.

(0044) Fig. 3 shows a second switching principle of the grounding of the turbine for increased protection requirements in the form of an artificial grounding.

(0045) In Fig. 1 the measuring system of the invention for residual dust monitoring in safety vacuum cleaners is drawn exclusively schematically as a block circuit diagram, in order to explain the electrical wiring of the measuring electrode 11 and the manner of function of the entire safety vacuum cleaner in conjunction with the measuring system 10. It is obvious that the electronic components 12 of the measuring system 10 are mounted in a separate module or on the housing 1 of the safety vacuum cleaner, which module is HF-protected. The measuring electrode 11 itself is arranged here, representationally for all other forms of execution, in the free end of the outlet channel 3. The turbine 5 with downstream-emplaced, rotationally symmetrical filter element 4 is sealed, sealed, off on the housing 1 of the safety vacuum cleaner, the upper part of which is represented here in section.

(0046) By operating of the turbine 5 now through the inlet channel 2 in flow direction 6 the medium to be drawn off (for example dust-containing air) is drawn into the interior of the housing 1. There the heavier drawn-in dust particles fall to the bottom and the lighter ones are carried along in flow directions 7 in the direction of the filter element 4.

(0047) Depending on pore size of the filter 4, then again larger particles are held back before or within the

filter 4, while smaller particles below the pore size of the filter 4 force their way preferably through the mantle surface of the filter 4 and are then drawn in the flow direction 8 in the direction of turbine blade 5.

(0048) In the turbine 5 the particles are then conveyed in the direction of the outlet channel 3, pass the zone of the measuring electrode and leave again the safety vacuum cleaner in flow direction 9. In the normal case with unblocked and nondefective filter 4 only the smallest particles (depending on pore size of filter 4) emerge from the safety vacuum cleaner. With a defective filter 4 undesirably many particles in all orders of magnitude (depending on defect) emerge from the safety vacuum cleaner. With block filter 4 virtually no particles emerge any more from the safety vacuum cleaner.

(0049) On contact of the particles with the grid-form measuring electrode, which extends over the entire cross-section of the outlet channel, the effect of the charge separation sets in as explained at the outset, and over the measuring electrode there flows a measuring current stream "i" in the direction of the evaluating unit. This measuring current rises with increasing number of contacts of the particles with the grid-form measuring electrode and thus the measuring current reflects very accurately the number of particles in the exhaust air. By the homogeneous distribution of the grid-form measuring electrode over the entire cross-section of the outlet channel there is achieved a statistical averaging and accordingly the number of particles can be

determined very accurately after a single calibration of the measuring system, although many of the particles, of course, pass through the measuring electrode without contact.

(0050) The calibration occurs over a predefined number of particles of medium size (depending on pore size of the filter) which is brought into correlation with the off-flowing measuring current from the measuring electrode.

(0051) Since the measuring currents are only very small (a few nA), these must first be fed over an entry line 13, for example to a differential amplifier 12 and be amplified there to several mA in order to give a signal to a further evaluating unit. The second entry line 12 is connected here with the turbine housing 5 and lies on ground there or on artificial ground, depending on grounding of the turbine housing 5.

(0052) This signal can indicate, for example optically or acoustically, whether a preset threshold value is exceeded, or whether it is undershot by blocking of the filter 4. It is also possible by this signal for a setting magnitude to be given directly from the evaluating unit and, for example, for the turbine 5 to be stopped and/or the filter 4 to be changed automatically in the housing 1.

(0053) A measurement of the particle number can also occur continuously, in order then to use these measurement values statistically in the after-engaged evaluating unit or a microprocessor and/or computer connected thereto.

(0054) These measurement values can then give information, for example, as to how rapidly and in what manner the filters 4 are blocked and/or become defective. Also through such statistics, for example, a production process can be replicated and/or monitored, in which dust-containing production wastes are drawn off. There can also be established, for example, a mathematical relation between tool and/or tool parameters with the concentration course of the particles over the time and/or place.

(0055) Fig. 2 shows a first switching principle for the grounding of the turbine for low protective demands, in which the housing of the turbine is grounded there, and the drive is represented schematically over phases and zero conductors and the switches $S_{1,1}$ present therein.

(0056) Fig. 3 shows a second switching principle of the grounding of the turbine 5 for increased protective demands in the form of an artificial grounding, in which the housing of the turbine 5 is connected over a protective resistor R and in each case at least one further resistance R_1 , R_2 with the phases and the zero conductor of the power supply of the turbine 5. The potential of the artificial grounding, therefore, depending on the relation of the resistances R_1 , R_2 and of the voltage divider, lies between the potential of the phase and the potential of the zero conductor.

Drawing Legend

- 1 Housing of the safety vacuum cleaner
- 2 Inlet channel
- 3 Outlet channel
- 4 Filter element
- 5 Turbine
- 6 Flow direction
- 7 Flow direction
- 8 Flow direction
- 9 Flow direction
- 10 Measuring system
- 11 Measuring electrode
- 12 Differential amplifier
- 13 Input line
- 14 Input line
- 15 Output line

R_1 Resistance

R_2 Resistance

S_1 Switch

S_2 Switch

Patent Claims

1. Residual dust monitoring in safety vacuum cleaners, characterized in that at least one measuring electrode (11) is mounted downstream behind the filter unit (4), which measuring electrode (11) conducts a current generated between measuring electrode and particles in dependence on the particle concentration, to a measuring value processing (12).

2. Residual dust monitoring in safety vacuum cleaners, according to claim 1, characterized in that the measuring electrode (11) is arranged downstream behind the filter (4) and behind the turbine (5).

3. Residual dust monitoring in safety vacuum cleaners, according to claim 2, characterized in that the measuring electrode (11) is arranged at the free end of the outlet tube (3) within this tube.

4. Residual dust monitoring in safety vacuum cleaners, according to claim 2, characterized in that the measuring electrode (11) is arranged in the vicinity of the turbine (5) in the outlet tube (3) or in the motor block of the turbine (5) itself.

5. Residual dust monitoring in safety vacuum cleaners, according to claim 1, characterized in that the measuring electrode (11) is mounted downstream behind the filter but in front of the turbine.

6. Residual dust monitoring in safety vacuum cleaners, according to claim 5, characterized in that the measuring electrode (11) is mounted downstream directly on or in the vicinity of the output surface of the filter (4).

7. Residual dust monitoring in safety vacuum cleaners, according to claim 5, characterized in that the measuring electrode (11) is mounted in an intermediate tube or an intermediate chamber between filter (4) and turbine (5).

8. Residual dust monitoring in safety vacuum cleaners, according to claim 5, characterized in that the measuring electrode (11) is mounted in the vicinity of the turbine blade in the turbine housing (5).

9. Residual dust monitoring in safety vacuum cleaners, according to claim 5, characterized in that the measuring electrode (11) covers the entire flow cross-section.

10. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 9, characterized in that the measuring electrode (11) is constructed in grid form and is mounted, electrically insulated, in the safety vacuum cleaner.

11. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 10, characterized in that the turbine (5) is either directly, or artificially grounded.

12. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 11, characterized in that the housing (1) is either directly, or artificially grounded.

13. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 12, characterized in that all parts of the safety vacuum cleaner coming in contact with the particles are either direct, or artificially grounded, with the exception of the measuring electrode (11).

14. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 13, characterized in that in the differential amplifier (12) the measuring current is suitably amplified and is conducted onward to a measuring value further-processing unit.

15. Residual dust monitoring in safety vacuum cleaners, according to claim 14, characterized in that the measuring-value further-processing unit carries out beatwise a desired value/actual value comparison and gives an output signal on undershooting or exceeding of the desired value.

16. Residual dust monitoring in safety vacuum cleaners, according to claim 15, characterized in that by this output

signal an optical and/or acoustic alarm is given, and/or that the turbine (5) is switched off, and/or that an automatic changing of the filter (4) and/or of the turbine (5) with filter (4) is performed.

17. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 16, characterized in that the measuring current is shown on a display continuously or at intervals of time, either directly or in the form of the number of particles to be correlated, or in the form of the proportional filter blocking, or in the form of the degree of filter damage.

18. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 17, characterized in that the value of the measuring current is recorded continuously or at intervals of time into a storage unit, which storage unit can be located in the safety vacuum cleaner itself or also externally.

19. Residual dust monitoring in safety vacuum cleaners, according to claims 1 - 18, characterized in that the evaluating unit is coupleable over an interface with an external data processing installation or a computer.

FIG. 1

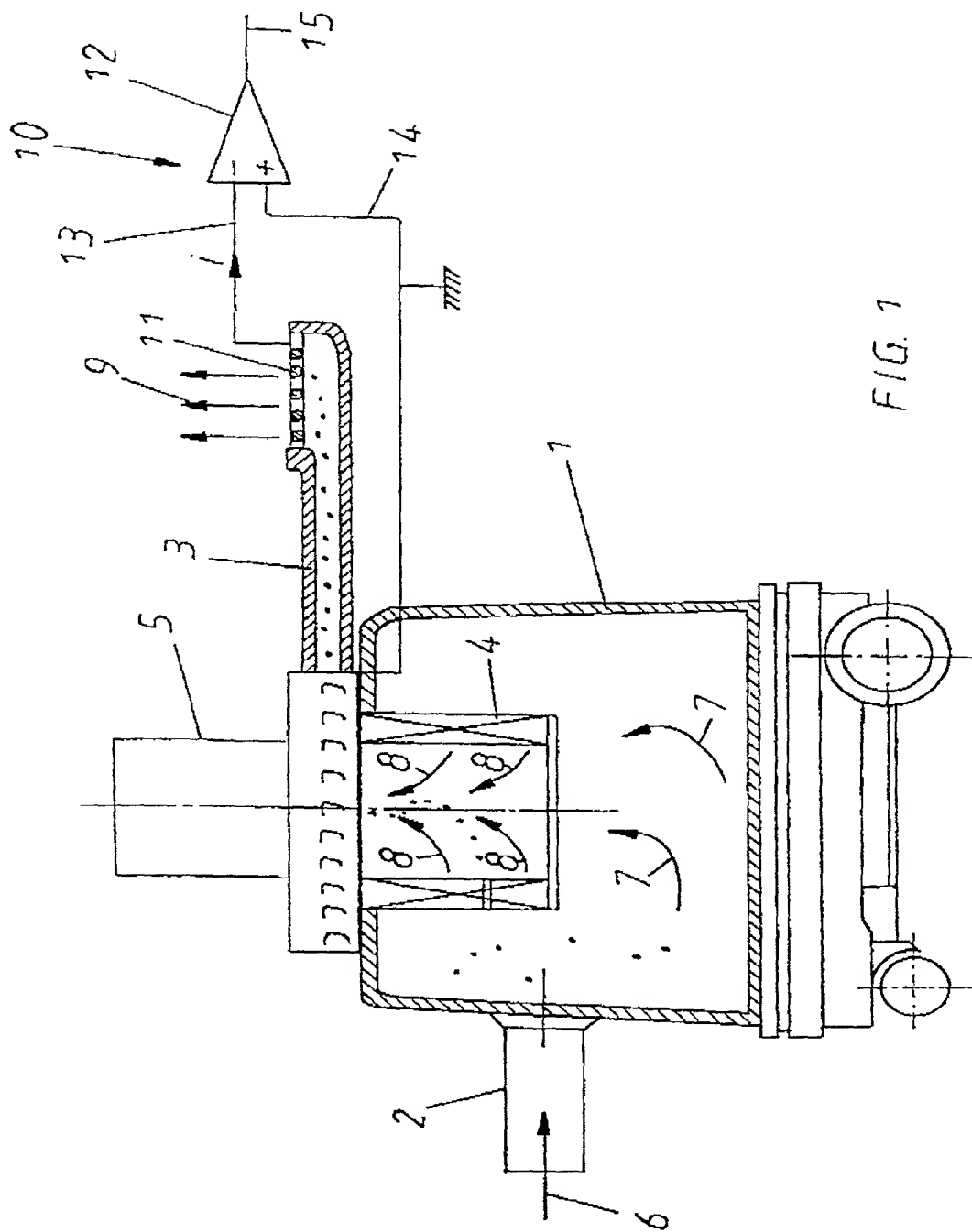


FIG. 1

2/2

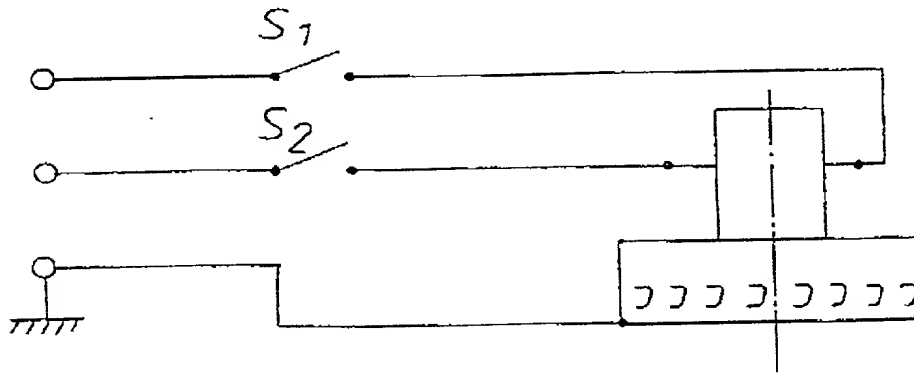


FIG. 2

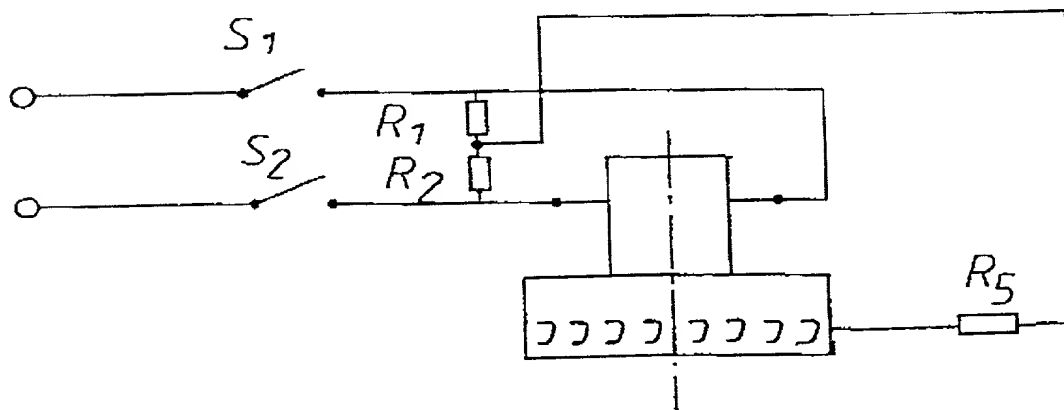


FIG. 3

Declaration and Power of Attorney for Patent Application

Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

deren Beschreibung hier beigelegt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☐ wurde angemeldet am _____ unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT) _____ und am _____ abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

MEASURING SYSTEM FOR THE CONTROL OF RESIDUAL DUST IN SAFETY VACUUM CLEANERS

the specification of which is attached hereto unless the following box is checked:

☒ was filed on December 10, 1999 as United States Application Number or PCT International Application Number PCT/EP99/09728 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder §365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslandsanmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

Prior Foreign Applications
(Frühere ausländische Anmeldungen)

199 00 484.6 ✓ (Number) (Nummer)	Germany ✓ (Country) (Land)
_____ (Number) (Nummer)	_____ (Country) (Land)

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

_____ (Application No.) (Aktenzeichen)	_____ (Filing Date) (Anmeldetag)
_____ (Application No.) (Aktenzeichen)	_____ (Filing Date) (Anmeldetag)

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PCT/ EP99/09728 ✓ (Application No.) (Aktenzeichen)	10 December 1999 ✓ (Filing Date) (Anmeldetag)
_____ (Application No.) (Aktenzeichen)	_____ (Filing Date) (Anmeldetag)

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08 January 1999 ✓ (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	<input type="checkbox"/>
_____ (Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	<input type="checkbox"/>

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Published (Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
_____ (Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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9-

Postanschrift:

Telefonische Auskünfte: (Name und Telefonnummer)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

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John F. Hoffman, BAKER & DANIELS

Direct Telephone Calls to: (name and telephone number)

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Vor- und Zuname des einzigen oder ersten Erfinders <i>1-00</i>	Full name of sole or first inventor <u>Wolfgang Nieuwkamp</u>
Unterschrift des Erfinders <i>[Signature]</i>	Inventor's signature <i>[Signature]</i>
Datum	Date <i>July 9th 2001</i>
Wohnsitz	Residence <u>Senden, Germany DEX</u>
Staatsangehörigkeit	Citizenship German <input checked="" type="checkbox"/>
Postanschrift	Post Office Address <u>Distelweg 8</u> <u>D-89250 Senden</u> <u>GERMANY</u>
Vor- und Zuname des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any
Unterschrift des zweiten Erfinders	Second Inventor's signature
Datum	Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Im Falle dritter und weiterer Miterfinder Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.) (Supply similar information and signature for third and subsequent joint inventors.)